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(71) Applicant: HANS JENSENS MASKINFABRIK A/S [DK/DK]; Smedevæget 3, DK-9560 Hadsund (DK).

(72) Inventor: LAURITSEN, Sven ; Tommelisevej 4, Dall Villaby, DK-9230 Svenstrup (DK).

(74) Agent: K. SKØTT-JENSEN PATENTINGENIØRER A/S; Lemmingvej 225, DK-8361 Hasselager (DK).

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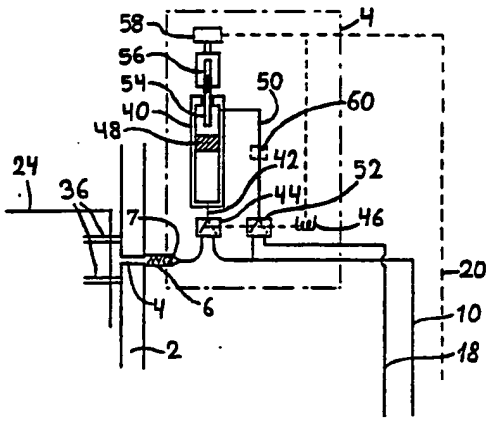
(54) Title: A LUBRICATION SYSTEM FOR SPOT LUBRICATION OF WORKING CYLINDERS IN LARGE PISTON MACHINES, PRIMARILY NAVAL DIESEL MOTORS



(57) Abstract

It has been customary to supply oil to the oiling points (4) of large diesel motor cylinders (2) through long pipes from so-called central lubrication devices comprising adjustable piston pumps driven in synchronism with the motor revolutions. It has already been recognized that there are certain problems with respect to an accurate oil dosage due to spring actions in the long pipes, and it has been suggested, without practical success, to use time controlled dosing valves instead, mounted near the respective oiling points (4), whereby the spring problem is minimized. With the present invention further improvements are achieved by using instead of the near-mounted valves respective automatically adjustable, volumetric metering and dosing units (8), which, between the oiling operations, are fillable by any required volume of oil, which, e.g. by the action of the supply pressure of the oil, can be dosed out to one or more oiling points with just the required volume, practically independent of occurring pressure changes in the supply system (18).

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A lubrication system for spot lubrication of working cylinders in large piston machines, primarily naval diesel engines.

The present invention relates to a lubrication system for dosing oil to one or more lubrication points in large piston engine cylinders, primarily in naval engines, and more specifically in the manner indicated in the introductory clause of claim 1.

For this purpose it has been customary to use so-called central lubrication devices, each of which operates in connection with the lubrication points of one or more cylinders by pressing out oil portions through respective connecting pipes to the various oiling points at relevant moments of time. These moments or short time intervals are precisely defined in relation to the movement of the engine piston in the cylinder, the oil supply through a considered lubrication point ideally occurring exactly at the brief time lapse where a set of associated piston rings on the piston passes the concerned oiling point. The lubrication of the cylinder wall becomes ineffective, if the oil is supplied at moments where the cylinder wall is not being swept by the piston rings or special by oil scraping rings, respectively, exactly adjacent to the individual concerned lubrication point.

Normally the central lubrication devices are controlled in synchronism with the revolutions of the engine crankshaft and it is therefore relatively easy to adjust the device for supplying the various portions of lubricating oil to the various oiling points at reasonably relevant moments of time. However, it has proven to be difficult to obtain an optimal lubrication, including a reasonably acute beginning and ending of the lubricating impulses, whereby it is necessary for obtaining a good oil dosage during the correct short

time lapse to prolong the lubricating period beyond this time lapse, which in turn causes a certain oil waste. The cause of this is the occurring elasticity or accumulator effect, which occurs in the external tubings between the lubrication device and the oiling points, this of course being most pronounced in connection with the longest of these tubings. The pipes should be reasonably easy to mount, and it is limited how sturdy and rigid they can be. Moreover, there will be a certain elasticity also in the oil columns in the pipes.

However, from DK-C-81,275 a proposal is known, in which the central lubricating device is replaced by or supplemented with dosing units which are placed immediately near the individual oiling points or groups of these and thus are connected therewith through relatively short pipes, these units acting as controlled closing valves between an oil pressure pipe and the oiling points. The associated valve members are actuated towards an open position by a spring or weight load, while they are electromagnetically actuated towards a closed position, such that from a switch unit, which is actuated in synchronism with the engine revolutions, they are operable automatically for opening at just the correct moments and through time lapses of an appropriately short duration. In the concerned publication it is mentioned that pure time control of corresponding dosing valves has been tried, but that this does not ensure injection of a correct oil quantity, and on this background it is proposed to use a combination of volumetric dosing from the oil pump and a time control of the dosing valve. Hereby it will be possible to obtain that the valve is brought to a sudden opening after the oil pump having built up the high pressure at the oiling point despite the said springing effect in the long connection pipe, as well as to a sudden closing before the same pressure starts to drop at the end of

the volumetric dosing from the pump. It is hereby possible, in a desired manner, to maintain a high injection pressure during each individual oiling sequence, but the total installation will be noticeably more expensive, and it will be difficult to produce a fast, automatically controlled adjustment of the effectively injected oil quantity depending on varying operational conditions. It is even indicated in the said proposal that a pressure oil accumulator may advantageously be used which is placed in immediate proximity to the inlet of the individual dosing unit, such that it is possible by the relatively sudden opening of the valve to maintain the desired high supply pressure of the oil in an extra safe manner. On the same background it would almost amount to an advantage that a certain elasticity occurs in the longer supply pipe for the pressure oil, also because on average there must be correspondence between the oil supply from the oil pump and the inlet of oil at the oiling point.

In consonance with the prior art it is a basic consideration in connection with the present invention that a primary aim is a lubrication with a determined oil quantity per round, even though it may be relevant to regulate this quantity, such as it is basically attempted by the use of the central lubricating devices, in which stroke adjustable piston pumps are provided for pressing out the oil to the individual oiling points or groups thereof. Only, in connection with the invention, it is realized that this principle may very well be applied without the said associated problems by a partial implementation of the known suggestion, viz. by the lubrication system being embodied as indicated in the characterizing clause of claim 1, i.e. in principle by effecting both the volumetric dosing and the time control by means of the locally placed dosing units.

The dosing unit or units being designed for

volumetrically determined intake and outlet of the oil portions, the latter will or may be correct regardless of the operating speed of the piston engine or the viscosity of the oil, and by the very fact of the dosing being controllable, an adaptation may easily be effectuated according to occurring parameter changes which may make such an adaptation desirable, e.g. a change of the oil viscosity. The dosing units may be embodied in a very simple manner, e.g. as simple cylinders with a piston or a piston plug which is displaceable between a fixed end of the cylinder and an opposed end, in which is provided a stopper rod insertable axially from the outside, which rod at the outside is in spindle-and-nut connection with a driving station in the shape of a step motor, which, controlled by the control unit, may quickly and easily direct the stopper rod into any relevant position with a high accuracy. The pressurized oil may be used for filling the cylinder by its own pressure until the piston abuts the axial stop, and thereafter the pressurized oil may be used for emptying the measured-out oil volume to the oiling point, viz. in being connected to the cylinder space at the opposite side of the piston. Thus, the dosing will require no further operation energy, except for the valve control itself.

The dosing units may be single-acting, with a working space which may be connected alternately to the inlet for pressurized oil, for filling of the working space, and to the oiling point for supplying oil thereto, and with a pressure champer, which is correspondingly alternately connectable to a return pipe and to the pressure oil inlet respectively, such that the piston may press out the oil in this champer during the filling of the working space and be pressed forwards by the pressurized oil for pressing out the measured-out oil volume. By this embodiment it will be possible to

make use of a differential piston, one part of which operates in a pressure chamber of increased diameter relative the working chamber, the space between this piston and the narrower working piston simply being permanently connected to said return pipe. Hereby the ordinary oil pressure may be used for providing a locally strongly increased oiling pressure at the dosing unit.

The dosing units may also be double-acting, the cylinder chambers on the two sides of the piston being connectable alternately to the pressure oil inlet and the oiling point, respectively. By such an installation the said return pipe may be altogether dispensable. Also by this arrangement there may be made use of a differential piston, in double, even though a return pipe must then be used.

In the following the invention is explained in more detail with reference to the drawing, in which

Fig. 1 is a schematic side view of a single cylinder of a naval diesel engine,

Fig. 2 is a more detailed sectional view of an individual oil injection unit used in connection herewith, and

Fig. 3 is a corresponding sectional view of a modified embodiment of the injection unit.

The cylinder shown in Fig. 1 has a cylinder liner 2 in which is provided a number of oiling holes 4, each of which is connected through a short pipe 6 to an associated injection unit 8. These units 8 are supplied with pressure oil through supply pipes 10 from a high-pressure pump 12 suctioning from a tank 14, to which is conducted a supply pipe 16 from a non-illustrated supply of lubricating oil, and a return pipe 18 from the units 8. Electrical control cables are indicated in dotted lines 20 from a control unit 22 to the individual units 8.

In the illustrated, normally preferred manner the cylinder is provided with a piston 24, which via a piston rod 26 and a connecting rod 28 is connected to a crank 30,32 in a crank housing. On the piston it is suggested that a pair of piston or scraping rings 36 are placed near the top of the piston, and the ideal is that the lubricating oil from each oiling point 4 be injected just when this pair of rings passes the concerned oiling point, which means in practice that the injection of the lubricating oil should take place by high power during a very short lapse of time.

The individual injection units in a preferred embodiment are constructed as shown in Fig. 2. As a main part, each unit has a piston cylinder 40 with an outlet pipe 42 connected to a switch-over valve 44, which, controlled by an actuator unit 46, may be switched to connection with the injector pipe 6 and the oil supply pipe 10, respectively. The short pipe 6 is provided with a check-valve 7, preventing backwards flow of oil from the oiling hole 4.

A piston 48 is mounted in the cylinder 40, and at its rear end the cylinder 40 is connected to a pipe conduit 50 leading to a switch-over unit 52 which is co-operated with the switch-over valve 44 in such a manner that the conduit 50 will be connected to the oil pressure pipe 10 when the outlet pipe 42 is connected to the injector pipe 6, while the pipe conduit 50 will be connected to the return pipe 18, when the outlet pipe 42 is connected to the pressure pipe 10.

Above the piston 48 is placed a stopper rod 54 projecting in through the upper rear end of the cylinder 40, which rod determines the maximally retracted position of the piston 48. In a manner not shown, this rod is secured against being rotated, and at its outer end it is in thread engagement with a stationarily fixed nut 56, which may be caused to rotate by a step motor 58

controlled from the control unit 22 in Fig. 1.

A pressure transducer 60 may be placed in connection with the pipe 50, and optionally a corresponding transducer may be placed at the outlet 42,6 from the cylinder 40. These transducers may be connected to the control unit 22 e.g. for control and supervision purposes. In a preparatory phase the valve unit 44,52 is held in such a position in which the pipe 42 is connected to the pressure pipe 10 at the lower end of the cylinder 40, while at the upper end of the cylinder the pipe 50 is connected to the return pipe 18. Hereby pressurized oil will be injected into the lower end of the cylinder 40, such that the piston 48 is pressed upwards until it abuts the end of the stopper rod 54. Thereby, an accurately determined volume of oil will be measured out in the cylinder 40 below the piston 48, given by the positioning of the stopper rod 54, i.e. by the signals received by the motor 58 from the control unit 22 through the cable 20. As shown by arrows in Fig. 1, the control unit 22 receives a plurality of different, relevant informations from various sensors in the system, such that the oil volume injected into the cylinder 40 will be appropriate for the subsequent supply of this volume through the oiling hole 4.

Immediately before the passage of the pair of piston or scraper rings 36 past the oiling hole 4, the control unit 22 will provide current to the activating unit 46 for switching the valve unit 44,52. This means that the lower end of the cylinder is now connected to the oiling hole 4 through the pipe 6, and that the upper end of this cylinder is connected to the pressure pipe 10 through the pipe 50, such that high pressure oil is conveyed to the space above the piston 48. Thereby this piston is thrust powerfully downwards so as to eject the oil portion in front of the piston with great force in front of the piston for delivery through the oiling hole

4 during a very brief time lapse, thus with an abrupt finishing of both the beginning and the ending phase of the opening period.

Immediately thereafter the unit 46 may be activated for resetting the switch valve 44,52, such that once more a new oil portion may be filled into the upper space of the cylinder 40. The filling will once more take place until the piston 48 abuts the stopper rod 54, the position of which may be currently adjusted by the control of the step motor 58 from the control unit 22, based on detections from different relevant sensors. Thus, mechanically it will be completely uncomplicated to arrange the control according to any desired criteria, inasfar as both the input and the relative or mutual weighting of the criteria may take place in the control unit 22. For instance, a detected reduced motor load may condition a reduced oil dosage, while at the same time, as a primary function, it may be desirable to increase the dosing, if a sudden change in the motor load has just occurred, also including a reduction hereof, as such changes may otherwise cause an increased cylinder wear. The increased dosing should be maintained through a certain period of time after the occurred change, e.g. 15-30 minutes, which may easily be adjusted by means of a timer and optional sensors connected thereto for detection of conditions which may influence the optimal length of the period through which the increased lubrication is maintained. It is not the purpose of the invention to indicate the concerned control parameters in more detail, but only to establish that the dosing units are easily controllable according to all thinkable parameters, when only the control unit 22 may convey the final result to the motor 58 or corresponding adjustment means, respectively, and to the activation unit 46,54 for the individual dosing units, regardless of the nature of this activation.

For obtaining that the dosings are accomplished with high force and speed, it may be desirable in connection with the shown arrangement that a pressure oil accumulator is placed in the inlet conduit 10 immediately in front of each of the switch-over units 52 or in front of various local groups of dosing units, e.g. merely in the shape of a slightly resilient container of a somewhat larger diameter that the inlet pipe 10, such that the required amount of oil may very quickly flow to the the rear end of the cylinder 40 by the activation of the valve 44,52, not requiring the inlet pipe 10 to have any particularly large diameter.

In the embodiment of the dosing unit shown in fig. 3, the pressure oil in the inlet 10 is stille used for pressing forward the piston 48 for dosing oil from the measuring chamber in front of the piston, but here the unit is designed as a double-acting unit. In position I, the shown change-over valve 62 sends pressure oil from the pipe 10 into the right hand end of the cylinder 40 through a pipe 64, while the left hand end of the cylinder is connected to a parallel change-over valve 66, position I, through a pipe 68. This valve is permanently connected to the concerned lubrication point or points through a short pipe 70.

As said, the pipes 64 and 68 are connected to the I-positions of the respective change-over valves 62 and 66, but moreover, they are connected through pipe extensions 74 and 76 to the II-positions of the respective opposite change-over valves.

The cylinder 40 is entirely oil-filled at both sides of the piston 48. With the pair 62,66 of change-over valves in the shown position II, the piston 48 will be in the illustrated end position to the right. When an oil portion is to be dispensed, the valve 62,66 is changed into position I. Pressure oil from the pipe 10 will then flow to the right end of the cylinder

through the valve 62 and the pipe 64. The piston 48 is thereby displaced to the left and presses out oil through the pipe 68 to the lubricating pipe 70. This pressing out abruptly stops, when the piston 48 abuts the left end of the cylinder.

At the same time the expanded space to the right of the piston 48 will be filled with oil, i.e. at the same occasion a new oil dose has been built up, the same quantity of oil having flowed in as what has been pressed out at the other side of the piston.

Next time an oil portion is to be dispended, the valve 62,66 is again shifted to position II. Pressure oil from the pipe 10 will then flow to the left end of the cylinder through the valve 66 and the pipe 68. The piston 48 is thereby displaced to the right and forces out the oil portion which was at the right side of the piston through the pipe 64, the valve 62 and the pipe 74 to the lubrication pipe 70. This forcing abruptly stops, when the piston 48 abuts the stopper rod 54.

The situation will now again be as shown in Fig. 3, i.e. new lubrication operations may be effected as described.

A quite important advantage of using the system shown in Fig. 3 will be that the entire installation may be arranged without any return pipes 18. The illustrated embodiments are based on the successive dosings of previously measured-out volumes of lubricating oil, but it will be appreciated that the invention is not limited thereto. Thus, the control unit, given some extreme situation, may interfere with the dosing process by shifting back the valve unit 44,46,52 already before the piston 48 has been pressed entirely forwards in the cylinder 40. The connection conduits 6 between the dosing units and the motor cylinder may be kept quite short, such that from a flow-technical point of view they may appear entirely rigid and thus without any

noticeable accumulator effect, as would be undesired here. However, it will be appreciated that e.g. by horizontal positioning of the cylinders 40, the dosing units will be placeable in direct connection with the cylinder lining, integrated with the associated oiling holes 4, whereby a possible accumulator effect may be suppressed. It is a further possibility that each dosing unit may be arranged so as to operate in connection with several lubrication points simultaneously, inasfar as normally several lubrication points are placed in the same cross section of the engine cylinder. Furthermore, an individual dosing unit will be able to operate in connection with several lubrication points at different moments, viz. through a suitable shifter equipment.

It should be noted that the dosing units do not necessarily have to be placed immediately next to the oiling points. Already the possibility of positioning right next to the cylinder area will entail a noticeable reduction of the length of the lubrication pipes relative to current practice, and optionally the units may then be placed in local groups.

In connection with the discussed embodiments it is the pressure oil per se which is used for producing the injection force, but the invention is not limited hereto. Optionally a compressed-air system may be used, e.g. in connection with a differential piston arrangement for amplifyring the pressure exerted on the dosing piston. Alternatively a strong electromagnet may be used for projecting the dosing piston against a suitable spring effect. In such cases the inlet oil does not have to be conveyed at any particularly high pressure.

PATENT CLAIMS:

1. A lubrication system for successive dosing of oil to one or more lubrication points in large piston engine cylinders, especially in naval motors, which installation comprises an oil pump and a dosing unit connected to the pressure side thereof, optionally several such units, which are preferably placed near the concerned lubrication points, each dosing unit being adapted so as to convey pressurized oil in an endavoured well-controlled amount to each connected oiling point by control from a control unit during predetermined short phases of the operative cycle of the piston engine, optionally with supplements of oil from an oil accumulator in proximity to the dosing unit, characterized in that the dosing unit or each of these units is provided as a volumetric measuring unit, which from the control unit is operable for controlled change of the measuring volume, and which is designed and arranged such that by a controlled opening of the connection between the dosing unit and the lubrication point or points it is operable to deliver the measured-out oil amount under influence of a pressure force which is activatable in a controlled manner, such as the pressure of an associated pressure medium system, preferably the inlet pressure of the oil inlet pipe itself and an oil accumulator optionally placed therein.

2. A system according to claim 1, characterized in that the dosing unit is provided with a measuring cylinder in which is mounted a piston or a piston plug, the mobility of which is limited, in at least one direction by a stop abutment, the position of which is

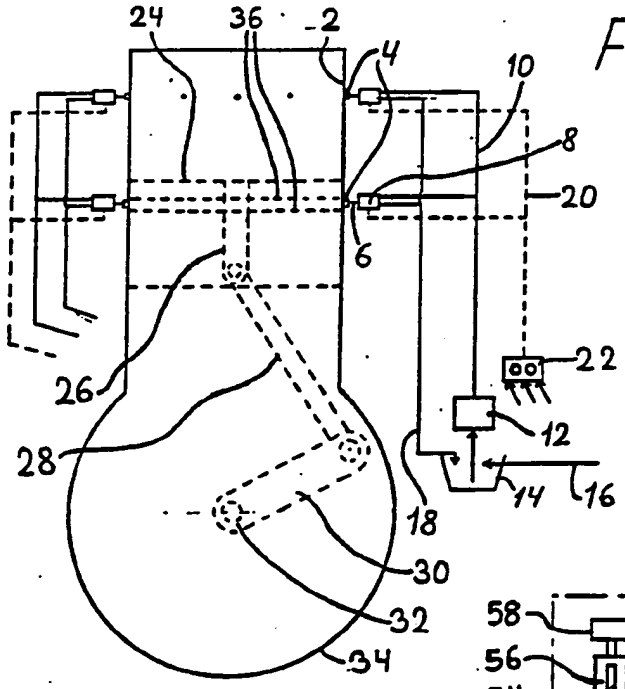
adjustable from the outside by means of a moving mechanism such as a step motor controllable by means of the control unit.

3. A system according to claim 1, characterized in that the dosing unit is connected to a pressure oil installation through associated individual control valves, which from the control unit are shiftable between a stand-by position in which the pressure oil may flow to a measuring chamber in the individual units for filling this chamber in the time lapse between the successive dispensings, and an lubricating position in which the pressure oil is used as a means for forcing out the oil in the measuring chamber to the respective oiling points.

4. A system according to claim 2, characrerized in that each of the opposed ends of the measuring cylinder is in pipe connection with a change-over valve block, through which blocks the respective opposed cylinder chambers at the opposed sides of the piston or piston plug are alternatingly connectable with a pressure oil inlet and an outlet connection to the lubrication point or points, respectively.

5. A system according to claim 1, characterized in that the control unit for current determination of the dispensing volume is of the type which is able to determine the lubrication need from a plurality of measured parameters in the operation system.

Fig. 1



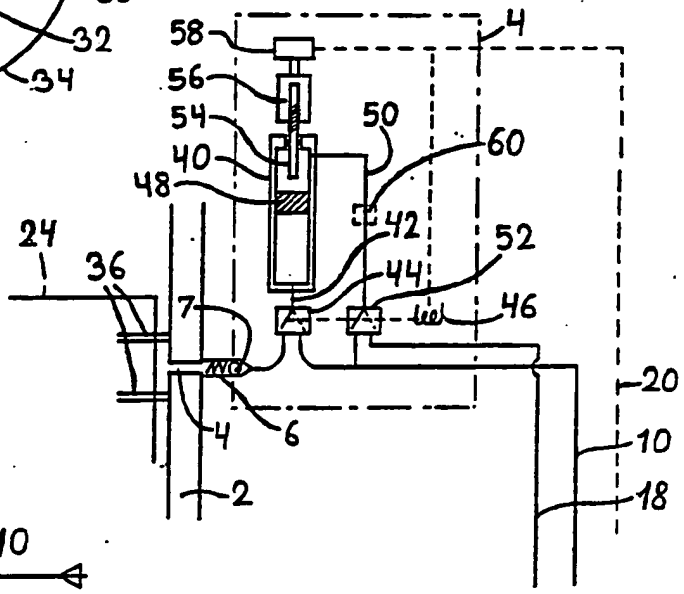
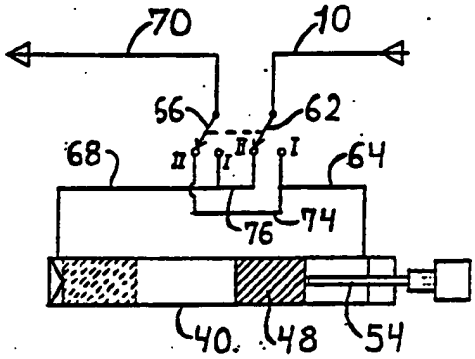


Fig. 2

Fig. 3



INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 92/00165

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 01 M 1/16

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 01 M; F 16 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	SE, B, 445672 (AB ERIK BOHLIN) 7 July 1986, see page 6, line 37 - page 7, line 8; figures 1,2 —	1
X	DK, C, 81275 (AKTIESELSKAPET BURMEISTER & WAIN'S MASKIN- OG SKI BSBYGGERI) 2 July 1956, see figures 1,2 see page 2, column 1, lastpart - page 2, column 2 —	1
A	EP, A2, 0049603 (THE BRITISH PETROLEUM COMPANY LIMITED) 14 April 1982, see page 4, line 11 - page 6, line 24; figures 1,2 —	1-5

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20th August 1992	1992 -08- 27
International Searching Authority	Signature of Authorized Officer
SWEDISH PATENT OFFICE	Jesper Stenström

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	DE, C2, 3909772 (MITSUBISHI JUKOGYO K.K.) 24 January 1991, see column 1, line 17 - column 2, line 42; figures 1-4; claim 1	1-5

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/DK 92/00165

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 01/07/92
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE-B- 445672	86-07-07	SE-A- 8006811	82-03-30
DK-C- 81275	56-07-02	NONE	
EP-A2- 0049603	82-04-14	JP-A- 57088212	82-06-02
DE-C2- 3909772	91-01-24	CH-A- 679171	91-12-31
		JP-A- 1244109	89-09-28